馬鈴薯毒素病之研究

1. 馬鈴薯X毒素病田間檢定

劉 康 鑑

一、緒 論

馬鈴薯之栽培在臺灣，主要在臺中縣幾個鄉鎮——豐原、后里、東勢、石岡、神岡等。栽培面積爲1165.30公頃，佔全面積1305.50公頃之89.25%[1]，其他縣市鄉鎮只有零星栽培。栽培品種以農林一號爲主，栽培季節集中於冬季，即第二期作水稻收成後至第二年第一期水稻挿秧前。每公頃收穫量最高年次爲53年，11,882公斤，尚不及瑞士等幾個國家栽培馬鈴薯收量之一半。

Table 1. Average yield of potato production in the different countries[2]

Countries	Average yield per hectere (Metric tons)	Countries	Average yield per hectare (Metric tons)
Switzerland	25.424	France	17.474
Norway	24.000	Austria	17.149
Belgium	23.651	Sweeden	16.222
Netherlands	23.625	Canada	14.323
Germany (West)	23.574	Japan	13.216
Ireland, Rep. of	22.035	Portugal	12.714
Denmark	22.292	Greece	11.385
United Kingdom	20.520	Chile	10.767
United States	19.597	Australia	10.372
Finland	18.204	Spain	10.229

Table 2. Annual average yield of potato production in Taiwan[1]

Year	Average yield per hectare (Metric tons)	Year	Average yield per hectare (Metric tons)
1954	4.842	1960	10.144
1955	5.523	1961	9.000
1956	5.951	1962	8.321
1957	6.650	1963	7.486
1958	6.980	1964	11.882
1959	8.055		

收量不高之原因很多，但以病害之影響爲最大。因爲馬鈴薯以塊莖繁殖，經塊莖傳播之病害特多。根據年來之觀察，於中部冬季栽培馬鈴薯之病害中，由菌類引起之病害以疫病爲最主要，次爲瘡痂病、黑痣病。疫病之發生可致使全園無一塊莖可收成之慘狀。幸近幾年來，經研究人員之試驗結果已推出幾種藥劑，得防患於未然。其他，毒素病之發生爲害亦甚大，常見者有捲葉病、縮葉病

本試驗之進行，承中國農村復興聯合委員會以 65-A-14-A-1672 第六項計劃資助，特此誌謝。

；壞疽嵌紋病則屬於少數。捲葉病發生於克難白（Kennebec），五峯、農林一號等品種，其罹病嚴重時幾達100%。縮葉病發生於長崎黃、五峯及農林一號等品種[3]。這些病害引起之減產，縮葉病爲2至5成，壞疽嵌紋病一成（第二年約五成），捲葉病5至8成[4]。

除上述肉眼可以觀察之毒素病外，尚有一種由馬鈴薯X毒素引起之潛在性嵌紋病（Latent mosaic），平常無特別病徵，與健全者並無二致。雖然不發生病徵，但影響產量，平均減產在10%左右[5][6][7]。如一年復一年栽植這些種薯，則引起很大的損失。並且强烈系統常常突然出現，隨而顯示病徵，有些系統偶而引起微斑病徵，爲此常使檢查結果前後矛盾。又田間有馬鈴薯Y毒素同時存在時，經蚜蟲之傳播，與X毒素形成混合感染，輕則漣葉病，重則縮葉病，其影響收量損失至鉅。

因該病害之影響如此嚴重，歐美諸先進國家及日本進行田間檢查，淘汰病株以保健全種薯，並於近十年來，採用血清方法檢出植株內之毒素，淘汰病薯，以保種薯之健全[7][8][9]。

在臺灣，馬鈴薯種薯以農林一號爲主，並仰求日本供給，每年輸入約250公噸，付出外滙雖不多，但由於每年輸入種薯，易帶進新毒素，而此毒素可能對其他經濟作物——尤其是煙草構成慘重之爲害。

所以毒素病乃影響馬鈴薯種薯自給自足之最大問題，如毒素病之問題能解決，則其他栽培問題即可迎刄而解。故罹患X毒素病株之淘汰，乃爲首先須要解決之問題。應用抗血清之方法爲目前唯一良策。於臺灣，郭氏[10]曾製造抗PVX血清並檢定不同馬鈴薯品種之罹患潛在性X毒素病之情形，但未曾應用於淘汰罹病植株。

爲瞭解現時在臺灣使用之種薯罹患X毒素病之情形，曾於中部五鄉鎮進行田間檢定，並爲試圖確立無病薯原種圃，曾數度前往新竹區農業改良場五峯分場，進行田間檢定，本文就在上列二處進行檢查之結果，加以分析檢討。

二、研究材料與方法

1. 供於試驗之兎子抗馬鈴薯X毒素血清，都份承臺灣大學植物病理研究室分讓，部份直接由荷蘭花卉種苗繁殖場分讓者，前者爲液狀，平常貯藏於冷藏庫（-20°C）輸送時則裝入保溫瓶內，並以乾冰冷凍，後者爲粉狀，裝於2公撮安培內，使用時加2公撮生理食鹽水，復爲液狀原液。

2. 檢查方法：以60磅道林紙糊成二面開口之紙袋，並按田間植株之實際排列情形，記以「行」及「號」（如第3行第5塊莖第2株等）。記有號碼之紙袋則只用於該號之植株。用紙袋採集嫩葉1—2枚，採集時注意手指不可接觸植株，以免傳染。

血清檢查方法，則採用玻片凝集法，以6—8倍之抗血清食鹽水稀釋液滴在清潔載玻片之一端，另一端則滴正常血清稀釋液或生理食鹽水爲對照。將所採樣本疊成小塊夾在二片一臺寸方塊之不銹鋼片之間，以鉗子壓出汁液在玻片上之抗血清及正常血清稀釋液上。用牙籤之各一端充分攪拌混合液，並前後搖動玻片。在抗血清及樣本汁液之混合中，可觀察棉絮狀沈澱，則表示標本中含有X毒素，若無此現象則表示陰性反應，無X毒素在樣本內。若天氣寒冷時加以適宜的溫度，促進反應之呈現。

三、結　　果

1. 調查不同來源之農林一號種薯田間罹患馬鈴蕃X毒素病之情形。

於民國五十四年一月間曾於新竹區農業改良場在臺中縣后里、豐原、石岡、神岡及東勢等五鄉鎮進行之種薯示範區，利用血淸方法，田間檢查不同來源農林一號種薯有無馬鈴薯X毒素之存在。該試驗區包括五個不同來源之種薯（表三），四個重複共二十小區，每小區二十個塊莖，每塊莖剖開爲四片共有八十片，則每小區有八十株馬鈴薯，種植方式以塊莖爲單位，四片排在一起，檢查時由每一塊莖單位之第一株採樣。

Table 3. Origins of Norin No. 1. potato seed tubers used in the experiment

Seed tuber	Origin
Wuling	From the summer crop, 1964, Wuling Farm
Japan	Newly imported from Japan, Fall 1964
Hoping	From the summer crop, 1964, Hoping Village
Spring	Refrigerated tubers from the spring crop, 1964, seed tuber used in the spring crop were imported in fall, 1963.
Winter	Refrigerated tubers from the winter crop, 1963, seed tubers used in the winter crop were imported in fall, 1963.

由檢定結果求出每小區之健全百分率，將百分率變成角度後[13]，按逢機排列法個別分析五處之結果如（表四），五處之分析結果經測驗均方純度，所得爲不顯著，卽表示五個均方由同一族羣中得來，所以五處之結果得合併分析[14]（表五）。不同來源之種薯 X 毒素最少者首推爲日本薯。由日本進口經臺灣自留種者，X毒素感率較高，但只有武陵薯與日本薯有顯著的差異。

Table 4. Serological examination of PVX distribution in Norin No. 1. potato plants from seed-tubers of different origins. (Jan. 1965)

Location / Origin	Ho-Li		Feng-Yuen		Shih-Kang		Shen-Kang		Tung-Shih	
	Percent	Angle	Percent	Angle	Percent	Angle	Percent	Angle	Percent	Angle
Wuling	3.75*	9.69**	23.75	29.00	6.25	12.45	8.75	11.53	8.50	13.54
Japan	10.00	18.44	42.50	40.63	62.50	52.42	26.25	20.86	16.25	23.22
Hoping	12.50	10.70	11.25	19.23	10.00	16.00	17.25	20.41	33.75	35.26
Spring	13.75	21.12	12.50	15.02	20.00	26.00	11.25	19.24	16.25	20.70
Winter	8.75	14.62	12.00	26.01	15.00	21.46	6.25	14.30	19.88	24.93
L. S. D. 0.05		N. S.		11.1		13.05		N. S.		12.99
L. S. D. 0.01				15.6		18.30				18.21

** Angle=Arcsin $\sqrt{\text{Proportion}}$

* denotes percentage of healthy plants

Table 5. Serological examination of PVX distribution in potato plants of Norin No. 1. variety from seed-tubers of different origins (Combined analysis)

Oringins	Mean Angle	Significant differences
Wuling	15.24	
Japan	32.34	**Wuling
Hoping	21.61	
Spring	29.91	
Winter	20.96	

** Significant at 1% level.

2. 於五峯分場進行田間檢定。自民國五十三年十一月間起至民國五十四年十二月止，前後三次前往新竹縣五峯鄉竹林村，新竹區農業改良場，五峯分場進行原原種圃田間檢定。馬鈴薯品種爲

農林一號，第一期之馬鈴薯係於民國五十二年秋季，由日本九州農林服務中心進口，經一期栽培，復於五十三年九月底種植者。其結果如表六。

Table 6. Field inspection for PVX by serological means at Wu-Feng Branch, Hsin-Chu Agricultural Experimental Station. Nov. Dec. 1964

Variety	Plants	Plants Examined	Plants of Negative reaction	Percentage of Healthy Plant (%)
Norin No. 1.	8088	7216	71	0.98

於五十四年三月間，第一期檢查結果無病株所產之塊莖供以第二期種植。同株同塊莖種植在一起，於同年五月間再行田間檢查。（表七）

復於同年十二月檢查以第二次檢查所得健全株所產塊莖種植之植株，其結果如（表八）。

經三次連續使用血淸方法田間檢查馬鈴薯X毒素病，並淘汰病株之結果，於第三次檢查時得60%左右之植株爲健全者。於第一次檢查7216株之中只有71株爲陰性反應者，尙不到百分之一數。於第二次檢查時有 43.33%之塊莖單位爲健全而於第三次檢查時有 59.56%塊莖爲陰性反應。

討 論 及 摘 要

現時在臺灣中部栽培之馬鈴薯，以農林一號爲主要品種。其對馬鈴薯X毒素病之感染性乃屬於健病混合羣，其感染率有時可達到 100%，若經嚴格田間檢定淘汰病株，並反復數次淘汰則可獲得全部無病植株。於中部不同來源種薯栽培示範區進行之利用血淸方法田間檢定結果顯示田間馬鈴薯含X毒素率相當高。於當季（53年秋）來自日本種薯亦含有X毒素 37.50%至 90%之多，平均爲 68.50%，其他自留種之感染率以武陵薯最高89.8%，和平薯 83.05%，春季薯爲 85.25%，冬季薯爲 86.02%。此批由日本新進口之種薯乃經日本農林省種薯繁殖場原原種及原種繁殖後移到採種圃由採種圃供給栽培者。於原原種及原種階段，近十年來皆用血淸方法田間檢定並淘汰病株(14)(15)；於採種圃則利用肉眼淘汰毒素罹病株。雖然經過如此手續尙不能避免感染。但以肉眼可以觀察之毒素病，如捲葉病及縮葉病（包括漣葉病）之發生，日本薯很明鮮的少於其他來源之種薯。以塊莖爲單位時，日本種薯爲 8.2%，和平薯 14%，春季薯 15.9%，武陵薯 25.8%冬季薯最高爲 42.2% (15)，影響收穫量很大（表九）。

Table 9. Yields of potato planting of different seed-tuber origins. (Jan. 1965)

Origin of seed tubers	Average yield (80 plants) Kilogram	Significant differences
Wuling	28.099	
Japan	35.026	**Wuling, Winter *Hoping
Hoping	31.134	**Winter
Spring	35.860	**Wuling, Winter *Hoping
Winter	25.937	

** Significant at 1% level.
 * Significant at 5% level.

由田間觀察，除捲葉病及縮葉病減少產量外，並無其他可成爲減產之原因，如春季薯之產量尙略高於日本薯，雖春季薯之毒素病發生較多，但日本薯於種植時休眠期尙未完全終了，致使發育較慢，收穫時亦未完全成熟，致使產量不能達到高峯，由此可見只要選種適當，在臺灣自留種並未較新進口種薯有遜，只是加何保持種薯之健全，以免無謂之損失乃是目前最重要之問題。

Table 7. Field inspection for PVX by serological methods at Wu-Feng Branch, Hsin-Chu Agricultural Experiment Station, 2nd trial, May 1965

		Tuber units derived from the same original plants, all healthy	Healthy tuber units in negative-positive reaction tuber unit groups of the same original plants	Healthy plants in negative-positive reaction plant groups of the same tuber units.	Healthy tuber units, plants
Original Plants[1]	63	24(38.10%)	—	—	24(38.10%)
Tuber units[2]	180	66(36.67%)	12(6.67%)	—	78(43.33%)
Plants[3]	513	187(36.45%)	23(4.48%)	20(3.90%)	230(44.83%)

1. Number of plants healthy in the lst trial, tubers derived from these were planted in the second crop.
2. Tubers planted in the second crop, which were derived from the healthy plant of lst trial.
3. Total plants in the experiment.

Table 8. Field inspection for PVX by serological methods at Wu-Feng Branch, Hsin-Chu Agricultural Experiment Station, 3rd trial, Dec. 1965

		Tuber units derived from the same orignal plants, all healthy	Tuber units derived from the secondary original plants, all healthy	Healthy tuber units in the negative-positive reaction tuber unit groups of the same secondary plants	Healthy plants in the negative-positive plant groups of the same tuber units	Heathy tuber units, plants,
Original plants[1]	22	8(27.27%)	—	—	—	6(27.27%)
2nd original Plants[2]	140	30(21.43%)	53(37.86%)	—	—	83(59.29%)
Tuber units[3]	361	71(19.67%)	110(30.47%)	34(9.42%)	—	215(59.56%)
Plants[4]	717	131(18.27%)	220(30.68%)	71(9.90%)	22(3.07%)	444(61.92%)

1. Number of plants healthy in the lst trial, tubers derived from these were planted in the 2nd and 3rd crops successively.
2. Number of plants healthy in the 2nd trial, tubers derived from these were planted in the 3rd crop.
3. Tubers planted in the 3rd crop, which were derived from the healthy plant of the 2nd crop.
4. Total nubmer of plants in the experiments.

於新竹縣五峯鄉新竹區農業改良場，五峯分場進行之田間檢定結果，第一次於總檢查數7216株中，只有0.98%為陰性反應，第二次及第三次，分別得到43%及59%之健全塊莖。由此看來，如單以肉眼鑑別淘汰病株，則對於不顯示病徵之植株無法淘汰，此為肉眼鑑別病株之最大缺點。栽培方式之不適當，如連續栽培，或株行、株距之長度不够，致使不同株之枝葉互相磨擦，傳染X毒素，亦常影響檢定成績。

為此，欲培育無病種薯，急需設置專掌機構，採取適當之栽培方式，除肉眼檢定淘汰病株外，並以化時間短而效率高之血清方法進行檢定淘汰，如此當可得到近乎百分之百之淘汰病株效果。

參 考 文 獻

(1) Dept of A. &. F. Taiwan Agricultural Year Book, 1965 Edition. Prov. Gover. of Taiwan.

(2) Monthly Bulletin of Agricultural Economics & Statistics. Vol. binos 7/8 1957. (錄自村山大記；馬鈴薯ウイルス病の免疫學的研究，北海道大學，1959)

(3) 劉康鑑：馬鈴薯毒素病研究，農試所五十年年報，P. 60–61, 1961.

(4) Murayama, D. Immunological Studies on the Potato Virus Diseases. P. 307, Hokkaido Universsty. Japan 1959.

(5) Bawden, F. C. Plant Viruses and Virus Diseases; Third Edition; 335 P. Chronica Botanica Co. U. S. A. 1950.

(6) Lombard, P. M. The effect of mild strain of latent mosaic virus X on yield of some of the new potato varieties in Maine. The American Potato Journal 27:445–449, 1950.

(7) Munro, James. Maintenace of Virus X-free Potatoes: Amer. Pot. Jour. 31:73–82 1954.

(8) 北海道中央馬鈴薯原原種場，馬鈴薯 X バイラス抗血清作成法存ならびに檢定法，P. 13, 1955.

(9) van Slogteren. F and D. H. M. van Slogteren; Serological identification on plant virus and serological diagnosis of virus diseases of plants. Ann. Rev. of Microbio. 11:149–164. 1957

(10) 郭國柱：馬鈴薯 X virus 抗血清之製造及應用，農試所五十年年報，PP. 38–41, 1962.

(11) 村山大記；血清學的實驗法：植物ウイルス病第六章，朝倉書店，日本 1960.

(12) Ball, D. M. Serological tests for the identification of plant viruses. P. 16, The American Phytopathological Society 1961.

(13) Snedecor. G. W. Statical Methods. P. 534, 1957.

(14) 葉樹藩：試驗設計學，第一部份生物統計學 P. 276.

(15) 北海道中央馬鈴薯原原種繁殖場；血清反應檢定による X バイラス淘汰馬鈴薯主要品種の X バイラス分佈調查成績 P, 10, 1955.

(16) 陳培昌：馬鈴薯種薯示範工作報告 (摘要) 2頁，新竹區農業改良場 1965.

STUDIES ON POTATO VIRUSES
1. Maintenance of Virus X free Potatoes

by

K.C. Liu

SUMMARY

The cultivation of Irisn potato in Taiwan is centered in the middle part of the island. Climate conditions at this part of the island in winter time are suitable for growing of potatoes. According to the Agricultural Year Book of 1965 edition, areas of 1,165.3 hectares out of the total potato producing areas of 1,305.55 hectares are located in this part. A Japanese variety, Norin No. 1 is the major variety of cultivation. The average yield per hectare is 12 metric tons, only half the yield of potato production in the European countries.

Since healthy table-stocks of local multiplication are not available, most tubers for planting are imported annully from Japan. It is necessary to self-supply healthy seed tubers in order to avoid possibly snaeking in of some plant viruses or strains of potato viruses new to this island. Toward the object of successful local multiplication of healthy seed tubers for sufficient fulfillment of demand, an attempt to obtain potato virus X (PVX) free seed-tubers had been made. Serological methods was employed to examine the distribution of the virus, morever, for the field inspection and the roguing of infected plants.

In January, 1965, examinations of PVX distribution among the potato plants from seed tubers of Norin No. 1 of different origins was carried out at five locations in the middle part of the island. The results showed that potato plants from seed-tubers newly imported from Japan are less infected by PVX than those from locally multiplied seed tubers. Average of 68.5% of newly imported tubers and 83.5% to 89.5% of locally multiplied tubers from different origins were infected by the virus.

Efforts had also been made to secure the source of PVX free seed-tubers by roguing infected plants. Field inspection for PVX by means of serological diagnosis, mainly chloroplast agglutination had been carried out three times at a upland branch of an Agricultural Experimental Station located in the northern part of the island, where the elevation is 1,000 meters (3,280 feet). Only seventy one PVX free plants were obtained from 7,216 plants examined in the first trial. About 43% and 60% of tuber units were healthy in the second trial and third trial, respectively.